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First Published Article of John Muir
on
Glacial Origin of Yosemite Valley and the Glaciation
of the Surrounding Regions

(from New York Daily Tribune, Tuesday, Dec. 5, 1871)

Yosemite Glaciers.

The Ice Streams of the Great Valley. Their Progress and present condition
Scenes among the Glacier Beds.

Yosemite Valley, Cal. Sept. 28 - Two years ago when picking flowers in the mountains back of Yosemite Valley, I found a book. It was blotted and storm-beaten; all of its outer pages were mealy and crumbly, the paper seeming to dissolve like the snow beneath which it had been buried; but many of the inner pages were well preserved, and though all were more or less stained and torn, whole chapters were easily readable. In just this condition is the great open book of Yosemite glaciers to-day; its granite pages have been torn and blurred by the same storms that wasted the castaway book. The grand central chapters of the Hoffman, and Tenaya, and Nevada glaciers are stained and corroded by the frosts and rains, yet, nevertheless they contain scarce one unreadable page; but the outer chapter of the Pohono, and the Illillouette, and the Yosemite Creek, and Ribbon and Cascade glaciers, are all dimmed and eaten away on the bottom, though the tops of their pages have not been so long exposed, and still proclaim in splendid characters the glorious actions of their departed ice. The glacier which filled the basin of Yosemite Creek was the fourth ice-stream that flowed to Yosemite Valley. It was about 15 miles in length by five in breadth at the middle of the main stream, and in many places was not less than 1000 feet in depth. It united with the central glaciers in the valley by a mouth reaching from the east side of El Capitan to Yosemite Point, east of the falls. Its western rim was rayed with short tributaries, and on the north its divide from the Tuolumne glacier was deeply grooved; but few if any of its ridges were here high enough to separate the descending ice into distinct tributaries. The main central trunk flowed nearly south, and, at a distance of about ten miles, separated into three nearly equal branches, which were turned abruptly to the east.

Branch Basins.

Those branch basins are laid among the highest spurs of the Hoffman range, and abound in small, bright lakes, set in the solid granite without the usual terminal moraine dam. The structure of those dividing spurs is exactly similar, all three appearing as if ruins of one mountain, or rather as perfect units hewn from one mountain rock during long ages of glacial activity. As their north sides are precipitous, and as they extend east and west, they were enabled to shelter and keep alive their hiding

glaciers long after the death of the main trunk. Their basins are still dazzling bright, and their lakes have as yet accumulated but narrow rings of border meadow, because their feeding streams have had but little time to carry the sand of which they are made. The east bank of the main stream, all the way from the three forks to the mouth is a continuous, regular wall, which also forms the west bank of Indian Canyon glacier-basin. The tributaries of the west side of the main basin touch the east tributaries of the cascade, and the great Tuolumne glacier from Mt. Dana, the mightiest ice river of this whole region, flowed past on the north. The declivity of the tributaries was great, especially those which flowed from the spurs of the Hoffman on the Tuolumne divide, but the main stream is rather level, and in approaching Yosemite was compelled to make a considerable ascent back of Eagle Cliff. To the concentrated currents of the central glaciers, and to the levelness and width of mouth of this one, we in a great measure owe the present height of the Yosemite Falls. Yosemite Creek lives the most tranquil life of all the large streams that leap into the valley, the others occupying the canyons of narrower and, consequently, of deeper glaciers, while yet far from the valley, abound in loud falls and snowy cascades, but Yosemite Creek flows straight on through smooth meadows and hollows, with only two or three gentle cascades, and now and then a row of soothing, rumbling rapids, biding its time, and hoarding up the best music and poetry of its life for the one anthem at the Yosemite, as planned by the ice.

Yosemite Basin

When a birdseye view of the Yosemite basin is obtained from any of its upper domes it is seen to possess a great number of dense patches of black forest, planted in abrupt contact with bare grey rocks. Those forest plots mark the number and the size of all the entire and fragmentary moraines of the basin, as the later eroding agents have not yet had sufficient time to form a soil fit for the vigorous life of large trees.

Wherever a deep-wombed tributary was laid against a narrow ridge, and was also shielded from the sun by compassing rock-shadows, there we invariably find one or more small terminal moraines, because when such tributaries were melted off from the trunk they retired to those upper strongholds of shade, and lived and worked in full independence, and the moraines which they built are left entire because the water-collecting basins behind them are too small to make streams large enough to wash them away: but in the basins of exposed tributaries there are no terminal moraines, because their glaciers died with the trunk. Medial and lateral moraines

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are common upon all the outside slopes, some of them nearly perfect in form; but down in the main basin there is not left one unaltered moraine of any kind, immense floods having washed down and leveled them into border meadows for the present stream and into sandy flower beds and fields for forests.

Glacier History.

Such was Yosemite glacier, and such is its basin, the magnificent work of its hands. There is sublimity in the life of a glacier. Water rivers work openly, and so do the rains and the gentle dews, and the great sea also grasping all the world; and even this universal ocean of breath, though invisible, yet speaks aloud in a thousand voices, and proclaims its modes of waking and its power: but glaciers work apart from men, exerting their tremendous energies in silence and darkness, outspread, spirit-like, brooding above predestined rocks unknown to light, unborn, working on unwearied through unmeasured times, unhalting as the stars, until at length, their creations complete, their mountains brought forth, homes made for the meadows and the lakes, moraine banks for chosen flowers, and fields for waiting forests, earnest, calm as when they came in crystals from the sky, they depart.

The great valley itself together with all of its various domes and walls, was brought forth and fashioned by a grand combination of glaciers, acting in certain directions against granite of peculiar physical structure. All of the rocks and mountains and lakes and meadows of the whole upper Merced basin received their specific forms and carvings almost entirely from this same agency of ice.

I have been drifting about among the rocks of this region for several years, anxious to spell out some of the mountain truths which are written here; and since the number, and magnitude, and significance of these ice rivers began to appear, I have become anxious for more exact knowledge regarding them; with this object, supplying myself with blankets and bread, I climbed out of Yosemite by Indian Canyon, and am now searching the upper rocks and moraines for readable glacier manuscript.

I meant to begin by exploring the main trunk glacier of Yosemite Creek, together with all of its rim tributaries one by one, gathering what data I could find regarding their depth, direction of flow, the kind and amount of work which each had done, etc., but when I was upon the El Capitan Mountain, seeking for the western shore of the main stream, I discovered that the Yosemite Creek glacier was not the lowest ice stream which flowed to the valley, but that the Ribbon Stream basin west of El Capitan had also been occupied by a glacier, which flowed nearly south, and united with the main central glaciers of the summits in the valley below El Capitan.

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Ribbon Stream Basin

I spent two days in this new basin. It must have been one of the smallest ice streams that entered the valley, being only about four miles in length by three in width. It received some small tributaries from the slopes of El Capitan ridge, which flowed south 35° west; but most of its ice was derived from a spur of the Hoffman group, running nearly southwest. The slope of its bed is steep and pretty regular, and it must have flowed with considerable velocity. I have not thus far discovered any of the original striated surfaces, though possibly some patches may still exist somewhere in the basin upon hard plates of quartz, or where a boulder of protecting form has settled upon a rounded surface. I found many such patches in the basin of Yosemite Glacier; one within half a mile of the top of the falls -- about two feet square in extent of surface, very perfect in polish, and its striae distinct, although the surrounding unprotected rock is disintegrated to a depth of at least four inches. As this small glacier sloped fully with unsheltered bosom to the sun, it was one of the first to die, and of course its tablets have been longer exposed to blurring rains and dews, and all eroding agents; but notwithstanding the countless blotting, crumbling storms which have fallen upon the historic lithographs of its surface, the great truth of its former existence printed in characters of moraine and meadow and valley groove, is still as clear as when every one of its pebbles and new-born rocks gleamed forth the full unshadowed poetry of its whole life. With the exception of a few castled piles and broken domes upon its east banks, its basin is rather smooth and lake-like, but it has charming meadows, most interesting in their present flora and glacier history, and noble forests of the two silver firs (*Picea Amabilis* and *P. grandis*) planted upon moraines spread out and leveled by overflowing waters.

These researches in the basin of the Ribbon Creek recalled some observations made by me some time ago in the lower portions of the basins of the Cascade and Tamarac streams, and I now thought it probable that careful search would discover abundant traces of glacial action in those basins also. Accordingly, on reaching the highest northern slope of the Ribbon, I obtained comprehensive views of both the Cascade and Tamarac basins, and amid their countless adornments could note many forms of lake and rock which appeared as genuine glacier characters unmarred and unaltered. Running down the bare slope of an icy-looking canyon, in less than half an hour I came upon a large patch of the old glacier bed, polished and striated, with the direction of the flow of the long dead stream clearly written -

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South 40° West. This proved to be the lowest, easternmost tributary of the Cascade glacier. I proceeded westward as far as the Cascade meadows on the Mono trail, then turning to the right, entered the mouth of the tributary at the head of the meadows. Here there is a well-defined terminal moraine, and the end of both ridges which formed the banks of the ice are broken and precipitous giving evidence of great pressure. I followed up this tributary to its source on the west bank of the Yosemite glacier about two miles north of the Mono trail, and throughout its entire length there is abundance of polished tablets with moraines, rock sculpture, etc., giving glacier testimony as clear and indisputable as can be found in the most recent glacier pathways of the Alps.

Vanished Glaciers.

I would gladly have explored the main trunk of this beautiful basin, from its highest snows upon the divide of the Tuolumne, to its mouth in the Merced Canyon below Yosemite, but alas! I had not sufficient bread. Beside, I felt sure that I should also have to explore the Tamarac basin, and, following westward among the fainter, most changed, and cover glacier pathways, I might probably be called as far as the end of the Pilot Peak Ridge. Therefore I concluded to leave those lower chapters for future lessons, and go on with the easier Yosemite pages which I had already begun.

But before taking leave of those lower streams let me distinctly state, that in my opinion future investigation will discover proofs of the existence in the earlier ages of Sierra Nevada ice, of vast glaciers which flowed to the very foot of the range. Already it is clear that all of the upper basins were filled with ice so deep and universal, that but few of the highest crests and ridges were sufficiently great to separate it into individual glaciers, many of the highest mountains having been flowed over and rounded like the boulders in a river. Glaciers poured into the Yosemite by every one of its canyons; and at a comparatively recent period of its history its northern wall, with perhaps the single exception of the crest of Eagle Cliff, was covered by one unbroken flow of ice, the several glaciers having united before they reached the wall.

September 30 - Last evening I was camped in a small round glacier meadow, as the head of the easternmost tributary of the cascade. The meadow was velvet with grass, and circled with the most beautiful of all the coniferae, the Williamson spruce. I built a great fire, and the daisies of the sod rayed as if conscious of a sun. As I lay on my back, feeling the presence of the trees -- gleaming upon the dark,

and gushing with life -- coming closer and closer upon me and saw the small round sky coming down with its stars to dome my trees, I said "Never was mountain mansion more beautiful, more spiritual; never was mortal wanderer more blessedly homed." When the sun rose, my charmed walls were taken down, the trees returned to the common fund of the forest, and my little sky fused back into the measureless blue. I was left upon common ground to follow my glacial labor.

Yosemite River Basins.

I followed the main Yosemite River northward, passing round the head of the second Yosemite tributary, which flowed about northeast until bent southward by the main current. About noon I came to the basin of the third ice tributary of the west rim, a place of domes which had long engaged my attention, and as I was anxious to study their structure, and the various moraines, etc., of the little glacier which had issued from their midst, I camped here close to the foot of the two of the most beautiful of the domes, in a sheltered hollow, the womb of the glacier. At the foot of these two domes are two lakes exactly alike in size and history, beautiful as any I ever beheld; first there is the crystal water center, then a yellowish fringe of *Carex*, which has long arching leaves that dip to the water; then a beveled bossy border of yellow *Sphagnum* moss, exactly marking the limits of the lake; further back is a narrow zone of dryer meadow smooth and purple with grasses which grow in soft plushy sods, interrupted here and there by clumpy gatherings of blue berry bushes. The purple *Kalmia* grows here also, and the splendidly flowered *Phyllodoce*; but these are small, and weave into the sod, spreading low in the grasses and glowing with them. Beside these flowering shrubs, the meadow is lightly sprinkled with daisies, and dodecatheons and white violets, most lovely meadows, divinely adjusted to most lovely lakes.

In the afternoon I followed down the bed of the tributary to its junction with the main glacier; then, turning to the right, crossed the mouths of the first two tributaries which I had passed in the morning; then, bearing east, examined a cross section of the main trunk and reached camp by following up the north bank of the tributary. Between the three tributaries above mentioned are well defined medial moraines having been preserved from leveling floods by their position on the higher slopes with but little water-collecting basins behind them. Down at their junctions where they were swept round by the main stream, is a large, level field of moraine matter which like all the drift-fields of this basin, is planted with heavy forests, composed mainly of a pine and fir (*Pinus contorta*, and *Picea amabilis*).

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This forest is now on fire. I wanted to pass through it but feared the falling trees. As I stood watching the flapping flames and estimating chances, a tall blazing pine crashed across the gap which I wished to pass, and in a few minutes more fell. This stirred a broken thought about special providences and caused me to go around out of danger. *Pinus contorta* is very susceptible of fire, as it grows very close, in grovy thickets, and usually every tree is trickled and beaded with gum. The summit forests are almost entirely composed of this pine.

Deer in the Valley

Emerging from this wooded moraine I found a great quantity of loose separate boulders upon a polished hill-top, which had formed a part of the bottom of the main ice stream. They were of extraordinary size, some large as houses and I started northward to seek the mountain from which they had been torn. I had gone but a little way when I discovered a deer quietly feeding upon a narrow strip of green meadow about 60 or 70 yards ahead of me. As the wind blew gently toward it, I thought the opportunity good for testing the truth of the hunters' accounts of the deer's wonderful keenness of scent, and stood quite still, and as the deer continued to feed tranquilly, only casting around his head upon his shoulder occasionally to drive away the flies, I began to think that his nose was no better than my own when suddenly as if pierced by a bullet he sprang up into the air and galloped confusedly off without turning to look, but in a few seconds as if doubtful of the direction of the danger, he came bounding back, caught a glimpse of me, and ran off a second time in settled direction.

The Yosemite basin is a favority Summer home of the deer. The leguminous vines and juicy grasses of the great moraines supply savory food, while the many high hidings of the Hoffman mountains, accessible by narrow passes, afford favorite shelter. Grizzly and brown bears also love Yosemite Creek. Berries of the dwarf manzanita, and acorns of the dwarf live-oak are abundant upon the dry hilltops; and these with some plants, and the larvae of black ants, are the favority food of bears, if varied occasionally by a stolen sheep or a shepherd. The gorges of the Tuolumne Canyon, on the north end of the basin, are their principal hiding places in this region. Higher in the range their food is not plentiful, and lower they are molested by man.

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On returning to camp I passed three of the domes of the north-bank, and was struck with the exact similarity of their structure, the same concentric layers, with a perpendicular cleavage also, but less perfectly developed and more irregular. This little dome tributary, about 2 1/2 miles long by 1 1/2 wide, must have been one of the most beautiful of the basin; all of its upper circling rim is adorned with domes, some half-born, sunk in the parent rock; some broken and torn upon the sides by the ice, and a few nearly perfect, from their greater strength of structure or more favorable position. The two lakes above described are the only ones of the tributary basin, both domes and lakes handiwork of the glacier.

A Glacier's Death

In the waning days of this mountain ice, when the main river began to shallow and break like a Summer cloud, its crests and domes rising higher and higher, and island rocks coming to light far out in the main current, then many a tributary died, and this one, cut off from its trunk, moved slowly back amid the gurgling and gushing of its bleeding rills, until, crouching in the shadows of this half-mile hollow, it lived a feeble separate life. Here its days come and go, and the hiding glacier lives and works. It brings boulders and sand and fine dust polishings from its sheltering domes and canyons, building up a terminal moraine, which forms a dam for the waters which issue from it; and beneath, working in the dark, it scoops a shallow lake basin. Again the glacier retires, crouching under cooler shadows, and a cluster of steady years enables the dying glacier to make yet another moraine dam like the first; and, where the granite begins to rise in curves to form the upper dam, it scoops another lake. Its last work is done, and it dies. The twin lakes are full of pure green water, and floating masses of snow and broken ice. The domes, perfect in sculpture, gleam in new-born purity, lakes and domes reflecting each other bright as the ice which made them. God's seasons circle on, glad brooks born of the snow and the rain sing in the rocks, and carry sand to the naked lakes, and, in the fullness of time comes many a chosen plant; first a lowly carex with dark brown spikes, then taller sedges and rushes, fixing a shallow soil, and now come many grasses, and daisies, and blooming shrubs, until lake and meadow growing throughout the season like a flower in Summer develop to the perfect beauty of to-day.

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How softly comes night to the mountains. Shadows grow upon all the landscape; only the Hoffman Peaks are open to the sun. Down in this hollow it is twilight, and my two domes, more impressive than in broad day, seem to approach me. They are not vast and over-spiritual, like Yosemite Tissiack, but comprehensive and companionable, and susceptible of human affinities. The darkness grows, and ~~of~~ all their finer sculpture dim^s. Now the great arches and deep curves sink also, and the whole structure is massed in black against the starry sky.

I have set fire to two pine logs, and the neighboring trees are coming to my charmed circle of light. The two-leaved pine, with sprays and tassels innumerable, the silver fir, with the magnificent fronded whorls of shining boughs, and the graceful nodding spruce, dripping with cones, and seeming yet more spiritual in this camp-fire light. Grandly do my logs give back their light, slow gleaned from suns of a hundred summers, garnered beautifully away in dotted cells and in beads of amber gum; and, together with this outgush of light, seems to flow all the other riches of their life, and their living companions are looking down as if to witness their perfect and beautiful death. But I am weary and must rest. Good-night to my two logs and two lakes, and to my two domes high and black on the sky, with a cluster of stars between.

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